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RE: Chad McCune and Carmen McCune, et al. v. Graco Children's Products, Inc., et al (C10-032)

INTRODUCTION:

By way of background, our office was contacted by Douthit, Frets, Rouse, Gentile & Rhodes with regard to Jason McCune a four year old child who sustained injuries while in a Graco booster seat. We were asked to perform an injury causation analysis.

INJURY CAUSATION ANALYSIS:

It should be understood that the process of evaluating injuries / forces (biomechanics) and kinematics in context with the vehicle dynamics of a motor vehicle accident is referred to as **Injury Causation Analysis**. This is the same analysis that I perform routinely in my job as a forensic / neuropathologist for the coroner's office. The same methodologies have been used in preparing this case as have been used for the last twenty five years. A forensic pathologist is a scientist. Daily investigations are in accord with the scientific method. To that end, a scientist investigates cases according to objective physical evidence and relates that evidence to real world events. These real world investigations are routinely performed in both the criminal and civil fields. Although the majority of the work I do involves persons who have expired, the information gleaned from the autopsy series allows me to better understand the injuries in people who survive their accidents.

I have performed over 8,900 autopsies and postmortem examinations. There have been over 876 autopsies on persons who have died in traffic related accidents. In view of the cases performed since 1993, there have been over 34 occipital C1 dislocations which have been diagnosed and analyzed at autopsy. Many more autopsies have been done on persons involved in other related accidents. Child related injuries are of particular interest due to my duties investigating childhood related traumatic brain-neck injuries. I have been involved in many criminal related cases where children have sustained either fatal or incapacitating brain and neck injuries. The so called shaken impact syndrome is one of the many cases we investigate at our office. We routinely evaluate and explicate the mechanisms of head and neck injuries. However, there are many other injuries that I evaluate that occur to children including torso/abdominal and orthopedic injuries either in criminal biomechanical injuries or children who are fatally injured in car crashes. In addition I routinely consult with police departments and district attorneys on persons who have sustained trauma and have survived their injuries. Lastly, I consult with civil attorneys on persons who have survived their injuries after being involved in a trauma related event. I have taught and continue to teach in the fields

of forensic pathology (biomechanics) in an academic setting as well as in the legal world where I continue to work with government related agencies.

As per my professional background, my medical degree is from Jefferson Medical College and I have six years of training in anatomic, forensic, and neuropathology at Emory University in Atlanta, Georgia. I am board certified in anatomic / forensic pathology and a fellow in neuropathology. As part of my formal training and continued study in forensic pathology / neuropathology, the types of injuries / forces needed to cause brain / neck and other anatomic injuries, under many different traumatic circumstances, have been studied under many different traffic accident dynamic scenarios.

These accident scenarios also involve the study of kinematics, which deals with body movements as a result of directional forces. Obviously this includes autopsies but additionally it includes working with Accident Reconstructionists and an understanding of vehicle dynamics in traffic related events. Thus, in many cases it was my duty to relate the kinematics of persons in the vehicle thus correlating with the vehicle dynamics. This study involves the use of the principal direction of force (PDOF). The PDOF is derived from Newton's Third Law which summarily concludes that the collision forces which occur at the time of impact are equal in magnitude but occur in opposite direction.

As it relates to the collision forces at the time of impact, the vehicle slows down and the energy is transferred to the vehicle compartments. Various regions of the vehicle are made to absorb energy. Thus the engine compartment will absorb energy in a frontal collision. Other regions in the vehicle are less able to absorb the forces in the accident thus in a side collision the likely hood that forces will be transmitted to the human body either by way of intrusion or impact with interior components increases with comparable changes in velocity during frontal collisions.

Thus it is not that speed in and of itself causes injuries; it is the sudden stop which causes injuries. This is referred to as the change in velocity (delta V). The change in velocity may be localized if the impact is point specific or it may occur to the whole body. The human body and its interior organs respond to accelerations that occur during the phasing of the accident. The external forces causes a change in motion to the internal organs and various forces can cause shear, bending, torsion, etc. to the body which results in injuries thus defined as the mechanisms of injury (biomechanics).

Typically speaking, a frontal crash into a flat rigid barrier at 30 MPH will cause frontal crush of approximately two feet. The change in velocity from 30 to 0 is a delta V of 30 MPH. The impact phase is somewhere around 100 ms and the average deceleration is around 15 Gs per two feet of total crush. As the vehicle terminates its velocity the occupant compartment begins to accelerate. The occupant moves forward in the car interior. The occupant continues at the initial speed until contact is made with the interior. Once this occurs forces begin to act on the human body. Initial forces occur to the feet. Then the knees contact the instrument panel. The upper torso including the head / neck complex impacts the interior components. If a restraint mechanism is employed in the crash then this slows down the body providing an effective ride down so that the impacts if they occur are less abrupt thus lowering the G forces to the body. This becomes important especially at it relates to survivable and non-survivable crash forces.

The primary forces in the collision provide an average deceleration to the passenger compartment which has been specified as approximately 15 Gs in a frontal crash at 30 MPH. The secondary forces are greater by orders of magnitude. Thus protective measures such as seat belts, airbags, and interior components can mitigate secondary crash forces. This becomes important as secondary forces can lead to significant head and torso organ injuries as well as orthopedic injuries. This is the result of the fact that even though the exterior regions of the body slow down or stop the interior regions continue to move until acted upon by another force (Newton's first law).

At present, I work as a forensic pathologist for Lancaster and Dauphin Counties in Pennsylvania. To this end, over 8,900 autopsies / postmortem examinations, hundreds of which involve traffic accidents with belted / unbelted occupants, have been performed. Vehicle dynamics and data, with regard to delta

velocity, G-forces, principle direction of force and other parameters, have been available during these examinations. In addition a comparative analysis between anatomic injuries and accident re-construction conclusions have been performed hundreds of times. It goes without saying that we have kept abreast with the latest medical / automotive literature over the last number of years.

One employs standard use of the scientific method and I am well acquainted with the same. The scientific method is routinely taught and employed in college, medicine, and forensic / neuropathology.

As per the scientific method, one proposes a hypothesis, formulates the problem, and then goes about analyzing data as part of an objective analysis. Once the information is reviewed, one formulates conclusions. These conclusions allow one to test the veracity of the hypothesis. It is at this point that one either accepts or disregards the hypothetical arguments.

In this particular case we reviewed/analyzed the police accident report, photographs of the vehicle, EMS reports, hospital medical records, photographs of the child, medical records of other occupants various depositions, the car seat in question, other expert reports, testing conducted by Graco, and surrogate analysis. We compared this data with the vehicle dynamics. We arrived at conclusions regarding the origins / types of occupant injuries and how these occurred during the accident scenario.

MATERIALS RECEIVED:

- Arkansas Uniform Motor Vehicle Collision Report.
- Arkansas State Police Photographs.
- Damascus Fire Department Fire & Rescue Report.
- EMS Report.
- Air Evac Lifeteam Report.
- Medical Records from Arkansas Children's Hospital.
- Radiology studies from Arkansas Children's Hospital.
- Photographs of Jason McCune in the hospital.
- Medical Records from Children's Medical Center Dallas.
- Photographs from Tina McCune including photographs of Jason in his booster seat prior to the accident, photographs of Jason in the hospital, photographs of the booster seat post accident, photographs of Sarah Parkison in the hospital, and photographs of the vehicle.
- Video of Jason in the hospital.
- Medical Records from Conway Regional Medical Center.
- Medical Records from Sparks Pediatrics.
- Medical Records from Trinity Clinic.
- Medical Records from Premier Pediatrics.
- Medical Records from Sparks Regional Medical Center.
- Medical Records from Windhaven Pediatrics.
- Medical Records of Carmen McCune from University of Arkansas Medical Center.
- EMS Report for Sarah Parkison.
- Air Evac Lifeteam Report for Sarah Parkison.
- Arkansas Children's Hospital Records for Sarah Parkison.
- Prior medical records for Sarah Parkison.
- Vehicle Inspection on June 18, 2010.
- Fit Check performed with Gary Whitman on July 30, 2010.
- Fit Check performed with Gary Whitman on November 11, 2010.
- Graco "Turbo Booster" in sled test (611661) photographs.
- Gary Whitman vehicle and subject seat photographs.
- OSI Smith v. Graco Plaintiff's and Defendant's Expert Reports.
- Smith v. Graco surrogate testing.
- Smith v. Graco automotive sled testing 2004 Hyundai Sonata performed by Exponent.

- Scifres v. Graco Chris Van Ee & William Van Arsdell videos.
- Smith (John) v. Graco Surrogate study and CRS Inspection photographs and video.
- Sled tests (gc0212oh and gc213oh) photographs and videos.
- Sled test (0407371) video.
- Graco sled tests with booster.
- Verifact photographs of exemplar vehicle.
- Verifact photographs of Accident site.
- Defendant Graco Children's Products Inc.'s Answer and Affirmative Defenses to Plaintiffs' Third Amended Complaint.
- Child Restraint System Tests – FMVSS No. 213 Britax Child Safety Inc. Wizard E9L07
- Deposition Transcript and Exhibits of Robert Lipsmeyer.
- Deposition Transcript and Exhibits of Steven Leonard.
- Deposition Transcript and Exhibits of Bobby Jackson.
- Deposition Transcript and Exhibits of Jamie Pritchard.
- Deposition Transcript and Exhibits of Carmen McCune.
- Deposition Transcript of Daniel Sutterfield.
- Deposition Transcript of Jennifer Ray Cummings.
- Deposition Transcript of Codey Nelson.
- Deposition Transcript of Rustin Lee Hitchcock.
- Deposition Transcript of William Cummings.
- Deposition Transcript of Michael Zadrozny.
- Deposition Transcript of Charles Crane.
- Deposition Transcript of Michael Langmaid.
- Expert Report of Scott P. Altman, P.E.
- Expert Report of Jerry G. Wallingford, P.E.
- Expert Report of Gary Whitman

POLICE ACCIDENT REPORTING FORM:

According to the police report, this accident occurred on southbound Route US 65 on July 29, 2007 at approximately 2:00 p.m. The weather conditions were clear, dry and it was daylight. Carmen McCune was driving a 2005 Ford Explorer Sport utility vehicle. Her vehicle impacted a John Deere tractor being driven in the right hand lane of Route 65 by Steven Leonard. The airbag deployed, and she was wearing her available three point restraint.

Also in the vehicle with Ms. McCune were her two children. Sarah Parkison, age 8, was seated in the number 4 position behind the driver's seat. She was wearing her available three point restraint. Jason McCune, age 4, was seated in the number 6 position behind the front passenger seat. He was in a child restraint (booster seat) with the available three point restraint system. Jason sustained significant injuries. Sarah sustained less significant injuries.

EMS/Fire Department:

Upon EMS/Damascus fire department arrival, Jason was found lying on the roadway. CPR was being administered. He had obvious abdominal injury. He was unresponsive with cardiac activity, a pulse, and agonal breathing. Upon physical assessment, abrasions, discoloration, distension, and signs of injury were noted to the abdomen. Seat belt injury noted to abdomen.

Jason was evacuated from the scene by Air Evac Lifeteam. Upon physical assessment, he was unresponsive with a GCS of 3. There was blunt abdominal trauma and head trauma injury was to be ruled out. Deformity was noted to the lumbar region. Abrasion was noted to the abdomen. Head to toe exam showed two abrasions and one small hematoma to the left forehead. The abdomen presented with an abrasion across

both lower quadrants consistent with seat belt mark (lap). Both upper and lower extremities were intact but no movement noted.

INJURY CAUSATION ANALYSIS:

It is the purview of a forensic pathologist to determine the cause of a person's injuries. To that end, we utilize the scientific method. There is a well established methodology utilized by a forensic pathologist on a daily basis.

In cases dealing with child related events such as that in a car seat, a booster seat, or even traumatic injuries from some other inflicting event, we follow a standard methodology. Initially, we gather the baseline evidence. This includes witness statements, medical evidence, scene analysis which, in this case, includes an analysis of the car, medical evidence, radiology evidence, and other expert review of the case in particular.

FIVE HYPOTHETICAL ARGUMENTS:

After establishing baseline information, we go through a rigorous scientific analysis in order to determine the cause of the injury. In order to do this, we have analyzed this case with five hypothetical arguments in view. The five arguments are as follows:

1. Jason was positioned in the seat facing forward with the lap belt appropriately positioned over his hips and the torso belt diagonally positioned over his right shoulder.

2. Jason was seated facing forward in the car seat with the lap belt positioned over his hips and the torso belt positioned behind his back but positioned underneath the left arm support.

3. Jason was seated facing forward in the booster seat with the lap belt positioned over his hips but the torso belt was positioned behind his back and, in addition, it was positioned over the left arm support.

4. Jason was seated facing forward in the booster seat with the lap belt positioned over his hips but the torso belt was positioned underneath the right arm pit.

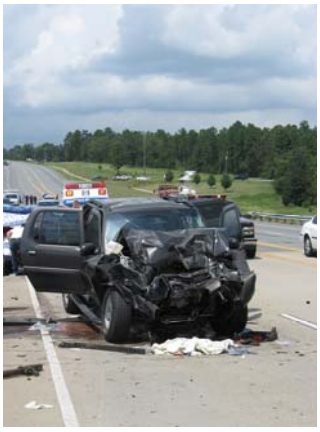
5. Jason was positioned in the seat facing forward with the lap belt appropriately positioned over his hips and the torso belt diagonally positioned over his right shoulder. But during the accident the shoulder belt reconfigured low on his abdomen and around his forearm.

These five hypothetical arguments were analyzed from a baseline perspective from the available physical evidence drawing from various investigations and medical evidence. In addition, we performed a surrogate analysis utilizing a surrogate of similar stature to that of Jason. During this surrogate analysis, we analyzed the movements and prospective injuries that would have been suffered by Jason if he were in the five different scenarios. This analysis was performed by Gary Whitman and I while at ARCCA. We utilized an exemplar Graco booster seat. We also utilized an exemplar Ford Explorer with the available three-point restraint. Before proceeding to this analysis there is baseline information which will now be entertained.

VEHICLE PARAMETERS AS IT RELATES TO INJURY CAUSATION:

By way of the **accident reconstruction**, this was a frontal impact. The impact occurred to the driver's side from the center of the vehicle at approximately -5 to -15 degrees. The impact resulted in front-end damage. As a result of this impact, the vehicle would stop. The occupants in the vehicle would continue to move according to Newton's First Law. The delta velocity addresses the change in velocity that occurs as a result of the accident and the vehicle slowing down. This typically occurs within 120 to 140 milliseconds in this accident. The delta velocity in this case is 28 and 36 mph. The average G force is 9 to 14. This delta

velocity is known to be within tolerable human limits, so we know that the speed change is at such a level and that its degree of change is not enough to result in the significant injuries to Jason especially with a well engineered well designed restraint system.



This is a frontal view of the damage to the Ford Explorer.

The **principal direction of force (PDOF),** which is the equal and opposite rule, is as a direct result of an impact to the vehicle. In this case, the principal direction of force has the body move forward and slightly to the left. Occupants in this vehicle would tend to move in this direction. Jason is in the right rear passenger seating area. He would move forward and slightly to the left. If he were unrestrained, or ineffectively restrained, he would move out of the seat because the forces are of such a degree that he would not remain confined to his seat.

As they move, they would engage the supplemental restraint systems. Three individuals were identified in the vehicle. There was a driver who was restrained by the available three-point restraint. There was a passenger in the driver's side rear seating position who was restrained by the available three-point restraint and there was Jason who was in the passenger side rear seating position, restrained by the available three-point restraint.

During the phasing of the accident, the occupants would engage the seatbelt systems. The purpose behind the systems is to restrain the individuals but provide them with effective ride-down so that, as the vehicle is slowing down, the passengers in their occupant seating capsules would slow down while riding-down on the restraint mechanism. From a biomechanical perspective, the seatbelt systems function to dissipate the energy allowing the body components to absorb the energy within tolerable load limits. Although the exterior of the body is restrained by these supplemental restraint systems, the interior components of the body continue to move forward and also must ride-down the process. To that end, the interior components of the body can suffer damage and injury, which injury is a guide to the various mechanisms that are in play that lead to injury patterns. Having said this, however, it is the purpose of supplemental restraint systems to protect the interior components of the body and limit injuries to the head/neck complex and the chest and abdominal region if not to prevent them entirely.

Before proceeding towards a more detailed analysis of the dynamics of body movement or so-called kinematics, we would, first of all, want to address the occupant seating capsule. From this perspective, the occupant seating capsule was well maintained. This means that the vehicle functioned to absorb the energy in the exterior components of the car including the bumper, the engine, and the mechanical engine elements in such a way to provide relief to the occupant seating area. There was **no significant intrusion noted to the occupant seating capsule** in Jason's arena. It is important to rule out intrusion as a mechanism of injury since intrusive components can change the dynamics of injury to the body.

This is a view from the driver's side showing the booster seat in the rear passenger compartment. The front passenger seat is positioned before the B pillar. The left arm rest is dislodged from the seat.

The last two components include **body position and restraint position** as well as its mechanistic functionality with respect to the human condition. By all accounts, Jason is positioned appropriately in his booster seat, facing forward at the time of the incident accident. Witness statements are quite conclusive in this area. A witness observes Jason in his seat just prior to the accident utilizing the shoulder belt in the proper location (Bobby Jackson). According to the static aftermath of the accident, Jason was still identified in the booster seat. He is flexed forward.

BOOSTER SEAT AND VEHICLE REVIEW:

A vehicle inspection was conducted on July 18, 2010 at the Diklich Facility. Those in attendance include: Doug Gentile, Chris Stucky, Gary Ladue, Katie Kelly, and Dr. Wayne Ross.

The vehicle in question is a 2005 Explorer Sport Trac XL2 4-door. The passenger doors can open and close. There is evidence of overt damage to the front of the vehicle; the engine head and the bumper are absent. Multiple fractures are noted to the windshield. The roof is deformed. The tires are inflated. Both air bags have deployed. The 2 front seats are present; however, the front passenger seat restraint is displaced forward.

The rear seats are present but not attached. The right rear seat is attached in the back. The center belt and rear-side seat belts are present.

The seat belt in the #6 position shows scalloping, which is present in the retractor. It is bunched up around the d-ring. Abrasions are identified to the d-ring. The remainder of the examination is to be performed by Gary Whitman. The belt is not removed. The center belt is noted.

The #4 position belt is appreciated. The webbing is bunched up at the d-ring, and the sliding latch plate is stuck in that area.

The rear region of the front seat passenger seat back is examined and shows abrasion to the left mid-region. This is photographed with a finger pointing to the abrasion.

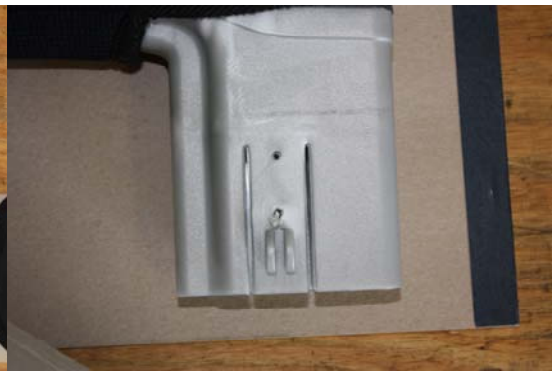
The driver's shoulder belt is also noted. The belt has a scalloped appearance/webbed appearance. Black transfer is appreciated to the under surface of the webbing. Abrasions are appreciated to the d-ring. The driver's seat belt d-ring shows a prominent abrasion.

We also received a Graco Turbo Booster, model 8491RGB, serial #JJ0402050720415. It was received in bubble wrap. Examination of the booster seat shows that the left arm rest is dislodged and displaced. Multiple photographs are obtained of the arm rest out of its position as well as near the area where it was displaced. The arm rest is intact. Abrasions are observed overlying the routing area, which represents the area of seat belt placement.

The left arm rest shows a scuff mark to the under surface of the cover. There are multiple areas of white discoloration representing stress to the plastic and the area in which the front side screw was placed shows evidence of damage. Comparison is made to the right arm rest where the front side screw is still in place.

The left side base top and bottom are separated upon examination. The tab has been disarticulated and identified outside the lower base. Stress marks are observed to the seat base.

Graco Booster Seat



Dissociated Left Arm Rest

MEDICAL ANALYSIS AND INJURY PATTERNS AS IT RELATES TO RESTRAINT MECHANISMS:

A significant component of forensic pathology is to analyze traumatic related injury patterns. To that end, we have analyzed many different injury patterns either by way of tool mark analysis and/or other pattern injury analysis. We have analyzed seatbelt related marks on the body as well as seatbelts themselves, correlating the patterns accordingly. In this case, we analyzed the seatbelt patterns on the body of Jason. To that end we analyzed the injuries to the occupant and performed a surrogate analysis; this test aided us in elucidating the mechanism of injuries to Jason.

At the outset, we want to understand the various injury patterns to the individuals in the vehicle.

- ◊ The mother sustained the following injuries: right bimalleolar fracture and avulsion fracture of the talus.
- ◊ The second child in the driver's side passenger seating area sustained the following injuries: avulsion to the right flank, large contusion across the abdomen consistent with seat belt sign, overall soft abdomen with distention and tenderness at the large seatbelt contusion; bowel evisceration, closed head injury, complex flank injury, distal sigmoid colon devascularization and descerosalization secondary to blunt abdominal trauma; positive loss of consciousness at the scene but alert and oriented upon hospital arrival; fracture of the right iliac bone, fracture in the left lamina of the L4 vertebral body; bilateral pedicle fracture of the L4 vertebra and fracture of the L4 sine with soft tissue swelling of the back of the left L4 and L5. Bilateral intraventricular hemorrhage in the occipital horn with left lateral periventricular leukomalacia with no skull fracture; C1 anomaly.

◊ The injuries sustained to Jason include the following. There is closed head injury, cervical spine injuries, abdominal injury, and lumbar spine injury. The abdominal injury is secondary to the seat belt (seat belt syndrome). Contusion to his forehead, traumatic brain injury consisting of subdural and subarachnoid hemorrhage, blood to the ventricles; an occipital C1 dislocation with associated infarct/traumatic contusion to the upper cervical cord resulting in quadriplegia; fracture/separation of C5/C6 vertebral bodies posteriorly with complete disruption of the posterior longitudinal ligament, small fracture of the superior endplate of the C6 vertebral body. There is a large right flank hematoma, soft tissue swelling and a lumbar step off fracture with edema at L1-L4. There are fractures of the L3 and L4 vertebral bodies (Chance fracture at L3 level with complete ligamentous disruption of the posterior elements at this level, epidural hemorrhage at the level of the T4 vertebral body, hemorrhagic infarct to the T11-L1 vertebral body regions, and edema to the posterior elements and perivertebral soft tissues), extensive retroperitoneal hemorrhage, hemorrhage along the transversus abdominous musculature bilaterally, free intraperitoneal fluid, shock bowel with wall thickening / bowel perforation, fluid in the perisplenic region, periportal edema, right flank region and in the pelvis. But no significant injury to the heart, lungs (atelectasis), liver, spleen, pancreas, kidneys, or adrenal glands. Multiple procedures were performed including explorative laparotomy, small bowel resection, colostomy as well as other.

According to the surrogate analysis: The height of the surrogate is 42 ¾". He weighed 43 pounds. He had a seated height of 24". Jason is approximately 41 ½" according to his growth chart. The growth chart projects this number along the 50% growth rate curve for a child of his age. There is a number at the hospital which is much greater than that on the growth chart, so that number is believed to be inconsistent with his height. He is approximately 40 +/- pounds.

The surrogate is of comparable height and weight to that of Jason. Thus, when reconstructing the response to collision forces and attempting to formulate injury patterns, it is the practice of the forensic pathologist to identify an individual, i.e. a surrogate, of similar height and weight and position them in the seatbelt/booster seat in the various positions in order to reconstruct the kinematics, i.e. movements of the body, at the time of the accident and to analyze injury patterns. The measurement from the rear seat to the rear of the front seat back was 29 ¾ inches.

INJURY PATTERNS:

In order to analyze the various injury patterns, we examined those that existed while at the hospital and compared that to the injuries that would exist if he were belted differently as observed in the five different hypothetical's presented above. In order to analyze the kinematics, we reviewed this from the perspective of the principal direction of force along with the injury patterns.

There are a series of photographs and a video from the hospital which depict the external injuries to the body. There are wounds appreciated to the lower abdomen, right inguinal region, and lower extremities; in particular, the right knee region. Pattern injuries are appreciated to the right upper extremity as well.

The first photograph shows a lap belt mark on the pelvis and shoulder belt mark on the abdomen and the right forearm. The second photograph shows a shoulder belt mark on the abdomen and the right forearm.

The injury pattern to the abdomen is to the right mid quadrant and the left mid lower quadrant indicative of the torso belt. The right mid quadrant wound shows a band-like abrasion pattern with the bruise pattern prominently identified from the anterior axillary line to the posterior axillary line along the right posterior lateral abdomen. The wound angulated downward to Jason's left as observed in the abdominal photographs. The reverse of that pattern would be that the wound ascends upward along the right side of the abdomen and along the right lateral abdominal wall. That pattern is primarily an abraded pattern which indicates frictional movement between the body and the belt. The lateral abdomen shows evidence of a friction abrasion with a bruise pattern more prominent noted posteriorly. The friction abrasion shows movement between the body and the belt and the bruise pattern shows blunt force impact but, obviously, less movement between the body and the belt itself; although there is a conjoining area of abrasion in the area. Although difficult to observe, there is an abrasion pattern noted to the left quadrant of the abdomen. The angle of that pattern is reconstructed with the overall pattern of the wound and the two are conjoining.

In addition, there is an abrasion pattern appreciated to the right inguinal region indicative of the lap belt. There are no comparable photographs of the left inguinal region.

A mark/bruise is observed to the right distal forearm. There are two transverse marks. There is an intervening blanched area. In addition, the blanched area has two circular bruises to the right forearm.

The right knee and lower leg shows evidence of abrasions. The left leg shows a bruise.

The radiographic images and, in particular, the CAT scan of the head shows evidence of swelling to the forehead. This finding indicates impact to that area. In addition, there is an occipital C1 dislocation. This is best observed on the CAT scan and the MRI scans. The CAT scan shows a dislocation injury and the MRI scan shows the infarct/contusion to the upper cervical region. There is no doubt that the injury to this area resulted in his quadriplegia.

Although there is injury noted to the abdominal contents and the lumbar vertebra/ cord region, including the bowel loops with periportal edema noted beneath the liver, there is no evidence of injury noted to the liver, spleen, lungs, kidneys, heart, or upper neck regions. No injury is noted to the subcutaneous soft tissues and/or the strap muscles overlying the tracheolaryngeal region. There is a lumbar region injury/bowel injury which would be due to the torso belt loading the abdomen and the spine.

Thus, in terms of the pattern of injury to the head/neck complex, there is an impact to the head with resulting hemorrhage to the brain and contusion/infarct to the upper cervical cord and injury to the lower vertebra-C5-C6 region. The mechanism of injury is as follows: This injury occurred as a result of forward flexion /whiplash motion of the head/ neck complex with impact to the forehead arresting any further movement to the complex. The impact would be to the forehead. The head abruptly stops and a major injury vector proceeds along the Z axis resulting in a shearing force at the occipital C1 region. This would result in the dislocation mechanism that was observed on the x-rays and the contusion/infarct to the upper cervical cord.

There is no injury observed to the top of the head, nor is there evidence of fracture to the top of the head that would be as a result of impact to that area. No contusions are noted to the cerebral cortex on the CT or the MR scans. Thus, the mechanism of injury is presently accounted for by the impact to the forehead. No other injury vectors are appreciated either to the top of the head or the back of the head that would account for the findings observed in the scans.

In terms of injuries, no injuries are noted to the front of the neck or the front of the chest or the mid abdominal region. Instead, there are injuries noted to the mid lower quadrant of the abdomen.

ANALYSIS OF INJURY PATTERNS WITH RESPECT TO SEATBELT MARKS AND OTHER IMPACTS:

There are two injury patterns to the abdominal region and the inguinal region. The inguinal region pattern is consistent with a lap belt mark. The bruise/abrasion pattern appreciated to the abdominal region, which ascends obliquely from a left to right direction corresponding to his body, is compatible with the shoulder belt.

The pattern to the right forearm is compatible with the torso belt wrapped around the outside of the forearm in that area. No other bruising/abrasion patterns are depicted in the photographs distal to the site of the pattern on the forearm. The lack of bruising abrasion patterns to the distal area confirms that the right forearm mark is not a result of flail effect. The injury pattern indicates a patterned object similar to the shape and size as that identified on the forearm and restricted to that area.

The abrasions to the right and left knee regions are compatible with impact forces. The findings are compatible with impact from the forehead of Jason.

The shear force through the occipital C1 region correlates with the impact to the forehead. In addition, it also correlates with flexion movements of the upper body. As the body flexes forward, the head/neck complex will come down and result in impact to the forehead. This will result in a major injury vector going up through the head at the occipital C1 region, resulting in the shear injury to that area. It will also result in forces to the brain that results in hemorrhages to that area.

There is a noticeable absence of injury to the front of neck and the chest and upper abdomen. The absence of injury, so-called void area, is compatible with the fact that there is, for whatever reason, no seatbelt to that area that would result in significant forces causing injuries to those organs.

In fact, the seatbelt marks appreciated to the lower abdomen correlate with the abdominal injuries. However, the marks are lower than that of the liver and spleen since there is no evidence of injuries to those organs.

The marks to the inguinal and abdominal regions are consistent with a lap belt mark and a torso mark. The overall pattern of the wounds is indicative of the pattern that would result from a lap and torso belt. However, only upon further testing are we able to discern the way in which the shoulder and lap belt would leave the marks on the body. Suffice to say, that the marks to the right forearm correlate with the torso belt. The marks to the right inguinal region and presumed left inguinal region, although not depicted in the

photographs, will correlate with the lap belt position through the routing loop and beneath the arm rest at the time of the incident.

The seatbelt pattern has particulars, which are best understood by examining it with respect to the sides of the booster seat. To that end, the pelvic compartment has the seat belt in the front; arm rests to both sides, and the back support in the rear. The abrasion pattern to the inguinal region indicates that the belt was in place and friction was limited to that area thus it left a mark to the front. This pattern makes sense when you compare it to the way in which the lap belt is positioned through the routing loops. The front of the belt would engage the lower pelvis traversing the routing loops which are at opposite ends of the booster seat, but the sides of the belt would engage the outside of the booster seat-not contacting the pelvis. The belt would be positioned down along the sides of the booster seat with the plastic arm rests in between the hip and the seat belt.

Thus, as the lower pelvis engages the belt, one would expect abrasions to the inguinal regions. There are no corresponding photographs of the left inguinal region. No seat belt abrasion pattern is appreciated along the right lateral pelvis which is to be expected since there is no belt to that area. There are, however, lateral pelvic marks/injuries which are compatible with impact from the right side of the booster seat.

Although there is a bland abrasion pattern to the inguinal region, it does not have any other particular features such as a striation pattern, which would indicate significant rotational movement between the inguinal region and the belt. This corresponds with the fact that the lower pelvis is confined to the booster seat compartment. On opposite ends of the seat are the lateral wings, which would mitigate lateral movement but not forward movement to the front of the pelvis. The seatbelt would engage the front of the pelvis during ride-down resulting in the pattern. Obviously, the rear of the base of the booster seat supports the lower back.

FIVE HYPOTHETICAL SCIENTIFIC ARGUMENTS:

The torso belt pattern has some curiosities, which on deeper inspection support the flexion movement of the upper body and rotation out of the belt during seat belt engagement. Let us consider the five hypothetical arguments as presented above.

Hypothetical Argument #1: Jason was positioned in the seat facing forward with the lap belt appropriately positioned over his hips and the torso belt diagonally positioned over his right shoulder.

In this position – **should he not rotate out of the belt** – one would expect a diagonal belt pattern extending upward from the lower abdomen to the right upper region of the chest. (This is confirmed by the surrogate who shows the pre-impact position with the orientation of the lap-shoulder belt restraints.) The pattern could be a bruise or abrasion pattern. In many cases, the pattern is primarily a bruise pattern. Bruises represent blunt force engagement injuries that result in hemorrhages to the skin or beneath the skin. Patterns are diagonal because of the implementation of the shoulder belt diagonally over the body. Thus simply stated, engagement of a diagonal belt in a diagonal fashion over the body would leave diagonal injuries. Typically speaking, the injuries may be present to the abdomen, chest, or the right shoulder region. The lap belt functions to engage the pelvis and the shoulder belt functions engaging the pelvis-sternum-right shoulder. Because these areas are of bone and since they are more durable in withstanding forces from the ride down they represent points of contact for seat belt engagement. So the following analysis is meant to compare the belt marks at the hospital with those expected should the belt stay on the pelvis and shoulder.

Surrogate with lap and shoulder belt.

There is a combination of patterns of injury identified to Jason and corresponding to the torso belt. The pattern is appreciated to the lower abdomen with a diagonal pattern arising from the left lower mid-quadrant of the abdomen and ascending to the right mid-quadrant-right upper quadrant of the abdomen. The pattern also extends along the posterior right side of the abdomen. To the front of the body, the pattern is primarily abraded. The pattern is essentially diagonal, ascending upwards from the left to the right side. On closer inspection the pattern becomes striated (superior-inferior). There are intervening skipped areas as well. The right lateral abdomen also shows an abrading pattern, but it ends abruptly and the pattern then becomes a bruise type pattern; thus, there is a combination of abrasion and bruise patterns to this region of the body. So the belt does not remain on the shoulder due to the lower abdominal abrasion pattern. But this does not rule out the belt originally being on the right shoulder since the right forearm pattern confirms that it must have been originally there.

It is of interest that the striated abrasion pattern is transverse diagonal and not vertically oriented. The intervening skipped areas probably represent clothing which is bunched up during the loading process. The abrupt change from an abrasion to a bruise pattern along the right lateral abdomen indicates that there is movement to the front of the body of a greater degree than there is along the lateral posterior regions of the body- back along the posterior axillary line.

In addition, there is a distinct pattern of marks noted to the outside of the right lateral forearm. The patterns are either linear transverse x 2 or irregular shaped bruise patterns.

The low patterns of injury indicate the relative movements of the body to the seatbelt system during the loading/engagement process. Since the lower abdomen is, by way of analysis of the injury patterns, confined to the lower compartment, it is relatively contained. The abrasion patterns indicate no movement from the lower inguinal region up to the abdominal region (submarining), nor do the internal injuries indicate movement of such a degree that it would account for descending movement of the abdomen relative to the lap belt. Thus, the lap belt engages the lower inguinal region; it engages it and remains confined to the inguinal regions. This is further corroborated by the position of the lap belt as it is routed through the lap belt regions of the booster seat.

Due to the fact that the abrasion patterns are transverse diagonal, one can conclude that there is relative movement of the torso to the torso belt, **thus the belt does not stay confined to the shoulder**. During the phasing of the accident, Jason's upper body would flex forward with the left shoulder rotating out of the

belt. This movement would continue forward as the shoulder belt, originally identified over the shoulder, would re-engage the lower abdomen. As he continues to rotate out of the belt, and because the belt is no longer positioned over his shoulder, there would be a sliding motion, which would appear as lateralizing posterior transverse striated abrasions on the lower abdomen. The movements of the upper body correspond with the abrasion pattern noted to the torso. Since the belt has re-engaged the lower abdomen, it would leave abrasions to the front and right posterior lateral regions of the abdomen. Because it is extending towards the anchor point which is posterior to the body, it would account for the abrupt pattern change; that is from an abrasion pattern to the bruise pattern since there would be less movement towards the posterior aspect of the body in comparison to the front. In spite of the change from an abrasion to a bruise pattern, the pattern is nonetheless continuous throughout. The overall image is compatible with the torso belt. Since the belt would re-engage the lower forearm, this would account for the pattern observed to that area. The re-engagement of the lower forearm also indicates that the belt was positioned over the right shoulder and in front of the body prior to the loading process. Thus, by looking at the exterior pattern alone, one can conclude that the belt was positioned in front of the body, diagonally across the body, up towards the right shoulder region prior to engagement.

We now turn to the internal analysis of the chest and abdomen including an analysis of the organ injuries for further study of the overall process.

It is of interest that there is no shoulder fracture, rib fractures, clavicle fractures, heart contusions, lung contusions, pneumothorax, hemothorax, torn aorta, marked hemorrhages to the mediastinum, lack of hemorrhage to the pleura, lack of hemorrhage to the superior mediastinum, lack of sternal fracture, and a relatively intact chest compartment. How do we account for the fact that we have a shoulder belt, which is engaged in the process and the lack of injuries to these areas? The disparity is quickly realized once one understands that during the loading process the upper body quickly engages and rotates out of the belt such that the belt is re-engaged to the lower region of the abdomen. This would account for the lack of injuries to the thoracic compartment. It would also account for the injuries to the lower abdomen, which results in the bowel injuries and the lumbar trans-fracture without significant liver or spleen injury. The mismatch between the original position of the shoulder belt and its resulting final position (injury pattern) indicates that there is some intervening event which resulted in this pattern: the intervening event is the rotation out of the belt.

Having characterized the external injury pattern as well as the internal injury pattern and correlated that with the configuration of the belt over the shoulder; and realizing that the belt did not stay on the shoulder as noted by the injury patterns- we now turn to examining the second hypothetical argument.

Hypothetical Argument # 2: Jason was seated facing forward in the car seat with the lap belt positioned over his hips and the torso belt positioned behind his back but positioned underneath the left arm support.

Seat belt under the arm rest and behind his back.

Hypothetical argument # 3: Jason was seated facing forward in the booster seat with the lap belt positioned over his hips but the torso belt was positioned behind his back and, in addition, it was positioned over the left arm support.

Seat belt over the arm rest and behind his back.

There are two hypothetical arguments here. One hypothetical argument has the belt looped under the left armrest and the other has the shoulder belt looped to the outside of the armrest. In either scenario, however, the shoulder belt is positioned behind the back of Jason. So suffice to say that both arguments are considered here.

It should be understood that, if the shoulder belt were positioned behind Jason, the shoulder belt would not contribute to any injury patterns to the front of the body. Thus, any injury patterns would have to be a result of the lap belt alone.

The lap belt is positioned on the pelvis. There is a routing loop positioned on both sides of the hips. The lap belt goes through this area. It latches to the buckle on the left side. The surrogate analysis shows the configuration of the lap belt to the body. As one observes the photographs, one will note that the routing loops are to both sides of the pelvis-over the front of the pelvis but through both routing loops and to the outside of the booster seat on both sides. Because of this, the sides of the pelvis of the surrogate do not interact with the lateral regions of the belt. Thus the front of the pelvis interacts with the front of the belt.

One can reasonably extrapolate from the surrogate analysis to Jason and entertain various scenarios during the phasing of the accident. As the impact occurs to front of the vehicle, the upper body of Jason would move forward. The pelvis would engage the lap belt but the upper body would be free to move forward

because of the unimpeded process and lack of ride-down due to absence of the shoulder belt. Once the pelvis engages the belt, marks would be made to the front of the pelvis. Photographs of Jason depict an abrasion to the right inguinal region compatible with a lap belt impression. However, in this scenario the body of Jason would continue to move because of the lack of upper body restraint and would slide underneath the lap belt. As noted in the surrogate photographs, the upper body would necessarily slide underneath the lap belt with the final resting place of the lap belt to the upper torso region.

Shoulder belt behind surrogate. Surrogate submarining under lap belt.

According to witness statements, Jason was observed still in his seat with his upper body flexed forward - his head/neck complex and upper body resting on his knees- in the post-impact position. This post-impact configuration is inconsistent with the previous hypothetical scenario in that the final resting place of the surrogate would have the belt high up on the chest region.

In addition, the post-impact position of the surrogate shows that the belt has been configured to the front of the body. This could leave abrasions to the front of the abdomen or the chest. The movement of the body underneath the belt could lead to vertically oriented or other distorted abrasion patterns originating at the inguinal region and continuing upward towards the chest. Those patterns do not exist on the body of Jason nor is there any medical evidence to support any such patterns.

Although there is an abrasion pattern to the abdomen of Jason, that pattern is inconsistent with a resulting pattern which would be present on the upper chest of Jason were he to slide underneath the belt. The pattern on the abdomen is not transverse (horizontal) but is on a diagonal. The abrasion pattern is lower on the left side than the right.

One might ask, could not his twisting movements while sliding under the belt account for the angulated abrasion pattern on the abdomen? The answer to that is no. The pattern is present to the front, right side - back of his abdomen. Thus, the pattern abrasion is in two different planes. There is a plane to the front of the body and a plane to the right side of the body. Because of the lap belt routing loops, because the sides of the booster seat would prevent lap belt impressions to the side of the body, and because of the dynamics of the accident with the impact noted essentially -5 to -15 off center; Jason, if he were to slide under the belt, would not significantly twist nor would there be abrasions from the lap belt to the right side/back of the abdomen because the lap belt would never contact the right side of the body. There is clearly an abrasion pattern to the right side/back of the body extending from the anterior axillary line to the posterior axillary line. This has been previously characterized in detail. This pattern is that of a belt configuration

and not that from the sides of the booster seat. If not the lap belt or the booster seat, what would cause the configured abrasion to the right side of Jason's body? The only remaining element in our scenario is the shoulder belt.

In addition, considering the original scenario with the shoulder belt behind Jason, one would anticipate on Jason, as represented in the surrogate photos – the lap belt configured horizontally across the chest region. Jason exhibits no abrasion patterns to the front of his body nor his chest that suggest a lap belt configuration Jason has no traumatic abnormalities to his skin, ribs, or internal organs of the chest that one would anticipate seeing if the lap belt were configured to the upper body. One would anticipate seeing a significant abrasion pattern, fractured ribs, injuries to the liver, spleen, lungs, heart and/or aorta. One would anticipate soft tissue injuries to the mediastinum. There are no injuries to the chest region. No abrasion patterns were appreciated underneath of the armpits bilaterally.

Nor would one expect the occipital C1 dislocation and resulting head injury observed on the CAT scans and in the medical records. As previously explained the head/neck injury mechanism is a result of forces from upper body flexion and head impact. Sliding underneath the belt would not allow for this mechanism to occur. In fact, the head/neck complex would slide down and be positioned over the booster seat and one would anticipate seeing an abrasion pattern or bruise pattern to the back, back of the neck, or the back of the head. No injuries were reported in the medicals to account for said mechanism. Thus, such an injury related process mechanistically is not supported by the medical evidence, the injury patterns and the surrogate study.

I reviewed a sled test prepared by Exponent. In this sled test a non-instrumented 6 year old dummy positioned in the right rear seating position in a 2004 Hyundai Sonata is subjected to two sled tests. In the first test the dummy is normally belted with the belt overlying the pelvis and the shoulder belt overlying the shoulder. In the second test the lap belt is positioned over the pelvis and the shoulder belt is positioned behind the back. In both incidences a Graco Turbo booster seat is being utilized. In the second test, the arm rest pops off. The dummy flexes forward and is almost ejected out of the belt but it certainly ejected out of the seat. This test is inconsistent with the injury patterns, post impact position of Jason, belt patterns on his body, and witness statements. I suspect that if Jason moved in a way similar to the tests, he would have injuries to the top of his head, other contusion patterns to his cerebrum, other neck injuries, and significant leg injuries. None of these findings are present on Jason. He was found in his booster seat. There are no belt injuries to his lower legs. Thus, this testing supports the fact that the belt was not positioned behind his back.

Hypothetical argument # 4: Jason was seated facing forward in the booster seat with the lap belt positioned over his hips but the torso belt was positioned underneath the right arm pit.

Seat belt under the arm rest and under his right arm pit.

In this scenario the shoulder belt would be positioned diagonally across the chest and abdomen and configured underneath the right armpit positioned underneath the arm and upward behind Jason. Thus the lap belt could lead to abrasions to the right inguinal region. If the belt is positioned under the right arm, it would be diagonal across the abdomen and chest. The surrogate illustrates the position of the belt. In this scenario the belt would engage the upper abdominal / chest region and result in rib fractures, liver injury, hemorrhage to the chest, lung and / or cardiac injury. None of these injuries were appreciated in the medical record or radiographic scans. The photographs of Jason at the hospital depict a shoulder belt mark which is down low on the abdomen. No belt marks are appreciated under the arm pit or across the chest. Lastly, one must examine the upper extremities of Jason to further characterize the configuration of the shoulder belt prior to impact.

A witness observed the shoulder belt properly configured over the front of the right shoulder prior to impact. During the post-impact phase of the accident, Jason was identified leaning forward with his head down towards the knees. The right arm was identified at his side with the belt to the outside of the right upper extremity.

The right upper extremity exhibits two distinctive marks which support the fact that the belt was over the right shoulder at the time of the impact phase of the accident. There are two linear transverse bruises with central blanching identified to the outside of the right forearm. The transverse pattern is consistent with a shoulder belt impression. The seatbelt mark would have to be over the right shoulder prior to impact in order for it to be present on the outside of the forearm in the post impact phase of the accident. In order for such to be the case, the body would have to rotate out of the belt and the shoulder belt would have to configure over the right forearm during that phase of the accident.

The post-impact position of the surrogate confirms the post impact position of Jason at the scene. In that picture, the body is flexed forward and the belt is configured down low to the abdomen and to the outside of the right forearm. The geometric orientation of the belt on the surrogate fits with the pattern of abrasions and bruises identified to the body of Jason. Additional support for the fact that the pre-impact position of the shoulder belt is over the right shoulder are the posterior lateral belt pattern as observed on the hospital photographs and the surrogate analysis. In the surrogate analysis the post impact position of the shoulder belt down low on the abdomen and lines up with the right forearm (pattern). Thus, if one simply connects the dots of the surrogate analysis, all external marks line up with the belt configuration if it is previously positioned on the outside of the right shoulder and not underneath it; and the internal injuries on Jason are consistent with this belt configuration as well.

Lastly, the sled tests performed by Graco also supports this contention and the physical evidence. Sled tests are performed during a frontal impact and during side impact. Early in the sled tests the dummy rolls out of the shoulder belt. This occurs even before the arm rest dislodges. In the other tests the arm rest comes off early. The shoulder belt pulls up on the arm rest and it comes off early in the crash pulse.

Test: GC0215

Test: GC0216

At a -10 degree PDOF, Jason would roll out of the shoulder belt with the left shoulder leading. Early on in the crash pulse the arm rest would come off. As confirmed in the sled tests and side impact sled tests, the pelvis moves up, his shoulder rolls out, and he loses pelvic containment.

The body moves to the left as he is rolling out but continues to flex forward. The arm rest has popped off and he flexes forward impacting his head / neck complex on his knees. The arm rest pops off in the sled tests. For example, test number 07062206, the arm rest pop off early in the test. In another test, 07062208, the body rotates out of the belt and the head impacts / near impacts the knees.

In these sled tests, the dummy, **which is a 6-year-old dummy**, is positioned forward in the booster seat. The lap belt is positioned over the pelvis and routed through the routing loops underneath the arm rests of the booster seat. The shoulder belt is positioned over the shoulder but underneath the arm rest.

The Hybrid III 6 year old child dummy is 44.9 inches tall with a sitting height of 25 inches. The total weight is 51.60 pounds. The Hybrid III 10 year old child dummy is 77.61 inches tall with a sitting height of 28.5 inches. The total weight is 77.61 pounds. These dummies are equipped to accurately measure neck loading, chest compression and Viscous Criterion. The skull is a two-piece aluminum casting with removable vinyl skin. An accelerometer pack is present to measure HIC. The neck is a flexible rubber construction with a center cable to limit elongation. The upper torso is a steel spine box which supports six high-strength steel ribs bonded to damping material. Two piece aluminum clavicle and clavicle link assemblies have cast integral scapulae to interface with shoulder belts. The limbs are vinyl skin over foam over welded steel skeleton. Rubber lumbar spine with center cable mounts on a lumbar load cell. The pelvis is vinyl skin over foam construction. The pelvic bone is welded aluminum with load cells on each ileum. The legs are vinyl skin over foam molded over a welded steel skeleton.

During the phasing of the accident, Jason's arm would move forward but be confined by the shoulder belt which made the mark on the right forearm.

Had the shoulder belt been positioned underneath the armpit region and the arm were to move freely forward, this would allow for flailing of the right and left arms. No patterns are observed to the left upper extremity. The right upper extremity has the previously designated patterns. In light of this scenario-the question has to be asked as to whether or not that pattern would be consistent with a flail pattern. The answer is no for the following reasons: The pattern is very distinct, transversely oriented, and outside the right forearm. There are linear, well-defined marks with central blanching which are located in an area

perfectly positioned where the seat belt would be reoriented in the accident if originally over the shoulder. If it were a flail related injury, one would not see such a pattern. Instead, one would expect an irregular shaped bruise pattern from impact to a car interior component. One would also anticipate an abraded bruise pattern due to the sliding motion between the right arm and the interior component of the vehicle.

After a thorough analysis of all of the injury patterns of Jason's exterior and interior body with the seatbelt configured in multiple different scenarios, we are left with one final scenario.

Hypothetical argument #5: Jason was positioned in the seat facing forward with the lap belt appropriately positioned over his hips and the torso belt diagonally positioned over his right shoulder. But during the accident the shoulder belt reconfigured low on his abdomen and around his forearm.

Surrogate analysis: Notice the position of the shoulder belt on the abdomen and around the right forearm.

This scenario was compared with the sled tests performed by Graco. It was remarkable how consistently the shoulder belt reconfigured during the movements of the dummy.

In addition, the sled tests were compared with the surrogate analysis, as well as the internal and external injuries of Jason. There was only one remaining scenario which conforms to the entire pattern of injuries observed to the body of Jason.

Jason is seated in his booster seat leaning forward as observed by the witness after the impact. Seconds before the accident, Witness Bobby Jackson observed Jason positioned properly in the seat with the shoulder belt in its proper location. As per our analysis, the shoulder belt is configured over the right shoulder. The lap belt is positioned over the front of the body of Jason. It is configured through the routing loops. It is latched to the buckle to the inboard side of the booster seat. The booster seat is in the number 6 position, directly behind the front passenger seat. The shoulder belt is configured over the right side of the shoulder or Jason.

The accident occurs to the -10 position of the front of the vehicle. Slack is introduced into the lap belt, possibly by way of the stuffed doll that was in between the lap belt and the body of Jason at the time of or prior to impact. It is my understanding that the mother asked Jason to remove the stuffed doll prior to the impact. Either prior to or by way of the impact, an element of slack is introduced to the lap belt system. The shoulder belt is still positioned over the right shoulder. The impact occurs and Jason moves forward

and to the left. His upper body engages the shoulder belt. His pelvis engages the lap belt as noted by the abrasions. It is during this time period that the left arm rest pops off of the booster seat. This is further confirmation that the shoulder belt is prepositioned underneath the left arm rest. The sled test videos also confirm that the left arm rest pops off during the loading phase engagement of the shoulder belt phase of the accident.

This introduces additional slack into the shoulder belt system. Because of this, the upper body is more readily able to rotate out of the belt, thus causing the sliding of the belt down towards the abdominal region and around the right arm. It is to be pointed out here that the movement of the body causes the sliding motion; thus, the belt does not stay snug to the upper body during this kinematic phase of body movement. The ride-down occurs as the belt engages the lower abdomen.

Although there is an element of slack to the lap belt, the hip engages it readily, thus accounting for the abrasion pattern and lack of submarining. The support from the under surface of the booster seat and the side supports of the booster seat- not withstanding the loss of the arm rest- help maintain the lap belt configuration on the pelvis throughout the process of loading.

The upper body now unrestrained continues to flex forward and the arcing motion of the body continues. The forehead impacts a body part, possibly one or two thighs or knees. The abrasion/bruise patterns appreciated to the knees are consistent with the impact. In any event, we know that there is impact from the forehead due to the bruise pattern and associated injuries to the head-neck complex. At this time, shearing forces are introduced at the occipital C1 region. These forces would result in the dislocation and contusion to the upper cervical cord, which resulted in paralysis.

In addition, the impact of the forehead would result in hemorrhage to the brain. These injuries are documented in the medical records as well as in the various radiographic scans. In spite of this, however, it is my understanding that he has recovered significantly from his head injuries and is cognizant and fully aware of his surroundings at the present time. Unfortunately, the same could not be said for his upper cervical neck injury, which has resulted in permanent paralysis.

At the close of his kinematic movements, he rebounds in his seat. He would rebound rearward. According to witness testimony (Bobby Jackson and Robert Lipsmeyer), he is ultimately found in his seat leaning forward with his head down by his legs. This position would represent the post-rebound phase of his kinematic movements. The right arm is restrained by the shoulder belt as it is down low on the abdomen. The shoulder belt is also observed to be low on the abdomen.

Out of the five scenarios which have been hypothetically entertained above, this last scenario neatly fits with all of the physical evidence and comports with the witness statements, accident dynamics, seatbelt configuration, kinematic movements of the body, sled tests performed by Graco, medical records, CT and MR scans, surrogate analysis and reconstruction of the kinematic movements, and expert reports. As per the Graco engineers, a properly positioned shoulder belt has repeatedly pulled out a properly installed arm rest. To date there are no tests which shows that a shoulder belt behind the back can pull out a properly installed arm rest.

In light of the above injury patterns, one must ask how to relieve the paralysis and how would one relieve the kinematic movements entertained in the above scenario.

By way of biomechanical analysis, the best way to effectuate and mitigate injury and injury patterns is to have a seatbelt system which provides an effective ride-down. These comments are not to reflect on the design of a seatbelt system, but to reflect on the biomechanical principles of a seatbelt system that would relieve or negate an injury to the neck region.

The bony areas of the body including the hips, the sternum, and the shoulder represent areas which, by virtue of their density and structure, can support greater forces than the soft tissues in the abdomen. Thus, a

seatbelt system whereby the lap belt is over the pelvis and the shoulder belt system configures over the sternum and the shoulders would effectively negate a neck injury as in Jason's case.

It is my understanding that Gary Whitman has proposed two alternative designs – Britax Wizard and Britax Boulevard. The alternative design which he proposes for this case would be a 5-point restraint system. In this system, there would be belt configuration as follows: A lap belt would overlie both hips. The central region of the chest would be loaded by a shoulder belt system and both shoulders would be loaded by a belt system as well. This 5-point restraint would offer the following during the kinematic movements of a frontal impact: As the surrogate moves forward in the seat, his lower hips would engage the lap belt. The lower restraint would be coupled with the upper restraint mechanism, which during engagement would result in configuration of the belt over the sternum and both shoulders. During forward movement of the upper shoulder regions, there would be engagement and ride-down of both shoulders and the sternum. The component of an additional shoulder belt would effectively restrain the upper torso during forward movement. As the upper body engages the upper seatbelt system, there would be effective ride-down of the upper body and the head-neck complex. The head-neck complex would still flex forward. The restraint mechanism would mitigate or militate against the head-neck complex arcing forward and impacting the lower body, thus obviating the forehead impact. There are a series of sled tests using the Britax Wizard prepared for NHTSA which confirm the kinematics. The testing complied with FMVSS 213 testing. The restraint was tested in the forward facing position with a 9 month old and a 3 year old dummy. The delta V was 30 mph. (In evaluating this system it should be understood that the human anatomy offers much more flexibility than the dummy which has less biofidelity at the spine.)

The lack of forward arcing with impact would prevent shearing forces from being vectored at the occipital C1 region. This would prevent a neck injury and would have prevented paralysis.

In light of the kinematic movements, a 5-point restraint system with this delta v in this accident, it is reasonable to conclude that Jason would have been able to tolerate these forces. It is reasonable to conclude that Jason's upper body movements would have been effectively restrained offering a better ride-down potential, thus preventing an upper cervical neck injury and paralysis.

After the Injury Causation Analysis, I can offer the following opinions to reasonable degree of Medical Certainty:

1. Jason was seated appropriately in the Graco Turbo booster seat behind the right front passenger seat. He was wearing his three point restraint with the lap belt over his pelvis and the torso belt over his right shoulder. The lap belt was routed through both routing loops.

2. In light of a delta V of 28-36 mph and a principal direction of force at approximately -10, he would move forward and to the left at the time of impact.

3. During his forward flexing movement, the left arm rest would break off and he would rotate out of the belt, flexing forward during this process. His head / neck complex would arc forward and sustain a forehead impact.

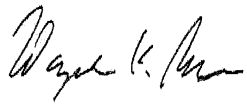
4. During his movements, the torso belt would reconfigure across his abdomen and around his right forearm. The lap belt would maintain its integrity around the pelvis. The lap belt would leave the inguinal injury. The torso belt would leave an injury across the abdomen which extends around the right side / back of Jason. The torso belt would result in abdominal injuries and spine injury.

5. During his movements, he would flex forward striking his head resulting in the forehead injury and closed head injury. In addition forces would be generated at the C1 region of the cervical cord resulting in infarct / contusion to that area. Jason's quadriplegia is a direct result of the cervical cord injury.

6. Had the arm rest not failed to provide lateral restraint in this accident, Jason would have benefited from the ride down of the shoulder belt and this would prevent the spinal cord injuries. The arm rest would have kept his pelvis contained in the seat under loading and prevented much if not all of the roll out in this event. The failure of the armrest was a substantial contributing factor to Jason's injuries.

7. An alternative design as proposed by Gary Whitman would involve the use of a five point restraint. Had such an alternative design been used in this case, it is reasonable to conclude that Jason could sustain mild to moderate injuries but more likely than not would not sustain any spinal cord or significant neurological injury; indeed no permanent neurological sequelae would have occurred.

Should further information become available, I reserve the right to amend this report at that time.



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REFERENCES:

1. DiMaio, *Forensic Pathology, Second Edition,* Chapter 6, Trauma to the Skull and Brain: Craniocerebral Injuries and Death Caused by Motor Vehicle Accidents (starting at page 281).

2. Leestma, *Forensic Neuropathology, Second Edition,* Chapter 6, Physical Injury to the Nervous System and Chapter 7, Child Abuse: Neuropathology Perspectives.

3. Spitz, *Medicolegal Investigation of Death,* Chapter XIX, Trauma of the Nervous System.

4. Love et al., *Greenfield's Neuropathology, Eighth Edition,* Chapter 11, Trauma.

5. Hyde, *Crash Injuries: How and Why They Happen*.

6. White, et al., *Clinical Biomechanics of the Spine, Second Edition.*

7. Duhaime, et al., *The Shaken Baby Syndrome: A Clinical, Pathological and Biomechanical Study,* J.Neurosurg. 66:409-415 (March, 1987).

8. Thompson, et al., *Assessment of Head Injury Risk Associated With Feet-First Free Falls In 12-Month-Old Children Using An Anthropomorphic Test Device,* J.Trauma, 66:1019-1029 (2009).

9. Howe et al., *Evaluation of Belt Positioning Booster Seats and Lap/Shoulder Belt Test Procedures,* NHTSA DOT HS 808 005 (October, 1992).

10. Weber, *Crash Protection for Child Passengers,* UMTRI Research Review, July-September 2000, Vol. 31, No. 3.

11. Johnson, et al., *Accidental Head Injuries in Children Under 5 Year of Age,* Clin.Radiology 60, 464-468 (2005).

12. Lancon, *Anatomy of the Shaken Baby Syndrome,* New Anat., 253:13-18 (1998).

13. Nagata, et al., *Analysis of Backward Falls Caused by Accelerated Floor Movements Using a Dummy*, Industrial Health, 45:462-466 (2007).

14. Delye, et al., *Biomechanics of Frontal Skull Fracture*, 24:1576-1586 (October, 2007).

15. Ibrahim, et al., *Biomechanics of the Toddler Head During Low-Height Falls: An Anthropomorphic Dummy Analysis*, J.Neurosurg. Pediatrics, 6:57-68 (July, 2010).

16. Walilko, et al., *Biomechanics of the Head for Olympic Boxer Punches to the Face*, Br.J.Sports Med., 39:710-719 (2005).

17. Sherwood, et al., *Factors Leading to Crash Fatalities to Children in Child Restraints*, 47th Annual Proceedings, AAAM (September 23-24, 2003).

18. Winston, et al., *Shifts in Child Restraint Use According to Child Weight in the United States From 1992-2002*, 47th Annual Proceedings, AAAM (September 23-24, 2003).

19. Johnston, et al., *Children in Car Crashes: Analysis of Data for Injury and Use of Restraints*, Pediatrics, 93:960-965 (June, 1994).

20. Naunheim, et al., *Comparison of Impact Data in Hockey, Football and Soccer*, J.Trauma, 48:938-941 (2000).

21. Sarron, et al., *Consequences of Nonpenetrating Projectile Impact on a Protected Head: Study of Rear Effects of Protection*, J.Trauma, 49:923-929 (2000).

22. Kleiven, et al., *Consequences of Head Size Following Trauma to the Human Head*, J.Biomech., 35:153-160 (2002).

23. Chang, et al., *Craniofacial Injuries from Slip, Trip and Fall Accidents of Children*, J.Trauma, 63:70-74 (2007).

24. Demask, *Injury Causation Analyses: Case Studies and Data Sources*, Appendix M, Head Injury Criteria and Integration of Injury Analysis.

25. Newgard, et al., *A Descriptive Study of Pediatric Injury Patterns from the National Automotive Sampling System*, 42nd Annual Proceedings of AAAM (October 5-7, 1998).

26. Stewart, et al., *Development of Child Occupant Injury Prevention Capacity Through Training of Fire and Rescue Personnel*, 40th Annual Proceedings of AAAM, (October 7-9, 1996).

27. Naunheim, et al., *Does the Use of Artificial Turf Contribute to Head Injuries?*, J.Trauma, 53:691-694 (2002).

28. Shields, et al., *Epidemiology of Cheerleading Fall-Related Injuries in the United States*, J.Ath.Training, 44:578-585 (2009).

29. Brown, *Existing Child Restraint Use Data – Does it Define the Problem?*, 42nd Annual Proceedings of AAAM (October 5-7, 1998).

30. Plunkett, *Fatal Pediatric Head Injuries Caused by Short-Distance Falls*, Am.J.Forensic Med.Path., 22:1-12 (2001).

31. Wickham, et al., *Head Injuries in Infants: The Risks of Bouncy Chairs and Car Seats,* Arch.Dis.Child, 86:168-169 (2002).

32. Bertocci, et al., *Influence of Fall Height and Impact Surface on Biomechanics of Feet-First Free Falls in Children,* Injury, Int.J.Care Injured, 35:417-424 (2004).

33. Murphy, et al., *Influence of Restraining Devices on Patterns of Pediatric Facial Trauma In Motor Vehicle Collisions,* Plas.Recon.Surg., 107:34-37 (2001).

34. Hiss, et al., *The Medicolegal Implications of Bilateral Cranial Fractures in Infants,* J.Trauma, 38:32-34 (1995).

35. Edgerton, et al., *Not All Child Safety Seats are Created Equal: The Potential Dangers of Shield Booster Seats,* Pediatrics, 113:153-158 (2004).

36. Brown, et al., *Patterns of Severe Injury in Pediatric Car Crash Victims: Crash Injury Research Engineering Network Database,* J.Ped.Surg., 41:362-367 (2006).

37. Mithani, et al., *Predictable Patterns of Intracranial and Cervical Spine Injury in Craniomaxillofacial Trauma: An Analysis of 4786 Patients,* Plast.Recon.Surg., 123:1293-1301 (2009).

38. Johnson, *On the Use of a Patient-Specific Rapid-Prototyped Model to Simulate the Response of the Human Head to Impact and Comparison with Analytical and Finite Element Models,* J.Biomechanics, 38:39-45 (2005).

39. Brown, et al., *Serious Injury is Associated with Suboptimal Restraint Use in Child Motor Vehicle Occupants,* J.Paediatrics and Child Health, 42:345-349 (2006).

40. Prange, et al., *Anthropomorphic Simulations of Falls, Shakes and Inflicted Impacts in Children,* J.Neurosurg., 99:143-150 (2003).

41. Wood, et al., *Skeletal Surveys in Infants With Isolated Skull Fractures,* Pediatrics, 123:247-252 (2009).

42. Javouhey, et al., *Are Restrained Children Under 15 Years of Age in Cars as Effectively Protected as Adults?,* Arch.Dis.Child, 91:304-308 (2006).

43. Mousny, et al., *Unusual Upper Cervical Fracture in a 1-Year-Old Girl,* J.Ped.Ortho., 21:590-593 (2001).

44. Muszynski, et al., *Risk of Pediatric Head Injury After Motor Vehicle Accidents,* J.Neurosurg. (Pediatrics 4), 102:374-379 (2005).

45. Lim, et al., *Associated Injuries in Facial Fractures: Review of 839 Patients,* 46:365-368 (1993).

46. Nee, et al., *Biomechanical Factors in Patient Selection for Radiography After Head Injury,* Injury, 24:741-745 (1993).

47. Bowers, et al., *Biomechanical Evaluation of Injury Severity Associated with Patient Falls from Bed,* Rehabilitation Nursing, 33:253-259 (2008).

48. Lapner, et al., *Children in Crashes: Mechanisms of Injury and Restraint Systems,* Can.J.Surg. 44:445-449 (2001).

49. Sweitzer, et al., *Children in Motor Vehicle Collisions: Analysis of Injury by Restraint Use and Seat Location,* J.Foren.Sci., 47:1049-1054 (2002).

50. MacKellar, *Head Injuries in Children and Implications for Their Prevention,* J.Ped.Surg., 24:577-579 (1989).

51. Graham, et al., *Injuries Associated With Child Safety Seat Misuse,* Ped.Emer.Care, 8:351-353 (1992).

52. Gurdjian, et al., *Reevaluation of the Biomechanics of Blunt Impact Injury of the Head,* Surg.Gyn.Ob., 140:845-850 (1975).

53. Martin, et al., *The Relationship Between Mass and Acceleration for Impacts on Padded Surfaces,* J.Biomechanics, 27:361-364 (1994).

54. Henderson, et al., *Adult Seat Belts: How Safe are they for Children?* Roads and Traffic Authority, Paper number 96-57-0-04.

55. Whitman, et al., *Booster-with-Shield Child Restraint Case Studies,* Copyright 1997 Society of Automotive Engineers, Inc.

56. Lane, J.C. *The Child in the Centre Seat*. Transport and Communications Federal Office of Road Safety (March, 1992).

57. Henderson, et al., *Children in Adult Seat Belts and Child Harnesses.* Department of Transport and Regional Development, The Federal Office of Road Safety (October, 1997).

58. Henderson, M. *Children in Car Crashes*. Child Accident Prevention Foundation of Australia, New South Wales Division (June, 1994).

59. Henderson, M. *In-Depth Study of Crashes Where Child Car Occupants are Injured, A Review of the Literature*. Child Accident Prevention Foundation of Australia (November, 1992).

60. Bacon, DGC. *Crash Restraint of Children by Adult Seat Belts and Booster Cushions.* Proc Instn Mech Engrs Vol 199 No D1, 49-63.

61. Lowne, et al., *The Effect of the UK Seat Belt Legislation on Restraint Usage by Children.* SAE 840526.

62. Henderson, et al., *Injuries to Restrained Children*. Child Accident Prevention Foundation of Australia (NSW Division), Sydney, Australia. 38th Annual proceedings AAAM.

63. Henderson, et al., *Performance of Child Restraints in Crashes and in Laboratory Tests.* Proceedings, Seat Belt Seminar, Commonwealth Department of Transport, Melbourne, Australia, (March, 1976).

64. Whitman, G. *NASS CDS Frontal Crashes (+/- 30 degree PDOF) 30+ mph Delta-v Cases Involving Children 1-5 Years, Using a Child Safety Seat*.

65. Comments of The Juvenile Products Manufacturers Association, Inc. on the Notice of Proposed Rulemaking regarding Revisions to the Federal Motor Vehicle Safety Standard for Child Restraint Systems. NHTSA Docket No. 2001-11707.

66. Sherwood, et al., *Prediction of Cervical Spine Injury Risk for the 6-Year- old Child in a Frontal Crashes.* Traffic Injury Prevention, 4:206-212, 2003.

67. Whitman, et al., *A Method for the Assessment of Tethered and Untethered Child Restraint Systems using the Hybrid III Three Year Old Dummy*. Injury Biomechanics Research, Proceedings of the Twenty Seventh International Workshop.